

**What is claimed is:**

1. A replaceable gas nozzle that is insertable in a gas distributor ring of a substrate processing chamber and that can be shielded within the chamber, the gas nozzle comprising:

a longitudinal ceramic body having a channel to direct the flow of the gas into the chamber, the ceramic body comprising a first external thread to mate with the gas distributor ring, a second external thread to receive a heat shield, the channel comprising an inlet to receive the gas from the gas distributor ring, and a pinhole outlet at the end of the channel to release the gas into the chamber.

2. A nozzle according to claim 1 wherein the pinhole outlet has a diameter  $d_o$ , and wherein the distance  $d_{st}$  between the second external thread and the pinhole outlet is about  $90d_o$  to about  $140d_o$ .

3. A nozzle according to claim 2 wherein  $d_o$  is from about 0.3 mm to about 0.4 mm.

4. A nozzle according to claim 2 wherein  $d_{st}$  is from about 30 mm to about 55 mm.

5. A nozzle according to claim 1 wherein the ceramic body is composed of aluminum oxide.

6. A nozzle according to claim 1 wherein the ceramic body is composed of aluminum nitride.

7. A nozzle according to claim 1 wherein the ceramic body tapers at an angle from about 35 to about 45° to the pinhole outlet.

8. A nozzle according to claim 1 further comprising a heat shield mounted on the second external thread.

9. A heat shield for shielding a nozzle extending into a chamber to introduce a process gas into the chamber through a nozzle outlet, wherein the chamber defines a processing region therein and has a substrate support to support a substrate for processing in the chamber, the heat shield comprising:

a hollow member configured to be coupled with the nozzle and having an internal dimension sufficiently large to be disposed around at least a portion of the nozzle, the hollow member having an extension which projects distally of the nozzle outlet and which includes a heat shield opening for the process gas to flow therethrough from the nozzle outlet.

10. The heat shield of claim 3 wherein the hollow member is cylindrical and has an internal cross-section which is larger than an external cross-section of the nozzle by about an amount smaller than the thickness of the heat shield.

11. The heat shield of claim 3 wherein the hollow member comprises a ceramic material.

12. The heat shield of claim 3 wherein the extension of the heat shield is sized to project distally of the nozzle outlet by a distance of between about a radius of the nozzle and about a diameter of the nozzle.

13. A heat shield according to claim 5 wherein the ceramic material comprises aluminum oxide or aluminum nitride.

14. A heat shield according to claim 6 wherein the extension projects distally by about 5 mm to about 8 mm.

15. A shielded gas nozzle for a substrate processing chamber comprising:

(a) a longitudinal ceramic body having a channel to direct the flow of the gas into the chamber, the ceramic body comprising a first external thread to mate with the gas distributor ring, a second external thread to receive a heat shield, the channel comprising an inlet to receive the gas from the gas distributor ring, and a pinhole outlet at the end of the channel to release the gas into the chamber.

(b) a hollow member configured to be coupled with the ceramic body and having an internal dimension sufficiently large to be disposed around at least a portion of the ceramic body, the hollow member having an extension which projects distally of the pinhole outlet and which includes a heat shield opening for the process gas to flow therethrough from the pinhole outlet.

16. A nozzle according to claim 1 wherein the pinhole outlet has a diameter  $d_0$ , and wherein the distance  $d_{st}$  between the second external thread and the pinhole outlet is about  $90d_0$  to about  $140d_0$ .

17. The heat shield of claim 3 wherein the hollow member is cylindrical and has an internal cross-section which is larger than an external cross-section of the ceramic body by about an amount smaller than the thickness of the hollow member.

18. The heat shield of claim 3 wherein the extension of the hollow member is sized to project distally of the pinhole outlet by a distance of between about a radius of the ceramic body and about a diameter of the ceramic body.

19. A shielded gas nozzle according to claim 1 wherein the ceramic body and hollow member are composed of aluminum oxide.

20. A shielded gas nozzle according to claim 1 wherein the ceramic body and the hollow member are composed of aluminum nitride.